ENABLE DHC

INVESTMENT PLAN

For the District Heating system in Rijeka

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Dissemination level		
SEN	Sensitive, limited under the conditions of the Grant Agreement	☐
PU	Public, fully open	☒

Nature of the deliverable		
R	Report, document	☒
DEM	Demonstrator, pilot, prototype, plan designs	☐
DEC	Websites, patents filing, press & media actions	☐
DATA	Datasets, microdata, etc.	☐
DMP	Data management plan	☐
ETHICS	Deliverables related to ethic issues	☐
SECURITY	Deliverables related to security issues	☐
OTHER	Software, technical diagram, algorithms, models, etc.	☐

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This template is prepared to support consortia participating in the LIFE Clean Energy Transition subprogramme in developing investment plans for existing or new district heating and/or cooling systems. The goal is to facilitate the preparation of plans that meet the "efficient district heating and cooling" criteria outlined in the Energy Efficiency Directive article 26, which is further explained in Commission Recommendation (EU) 2024/2395 [1].

[1] Commission Recommendation (EU) 2024/2395[1] of 2 September 2024 setting out guidelines for the interpretation of Article 26 of Directive (EU) 2023/1791 of the European Parliament and of the Council as regards the heating and cooling supply, available at https://eur-lex.europa.eu/eli/reco/2024/2395/oj/eng

1. Case Study Context and Transformation Objective

The Rijeka District Heating System (DHS), operated by municipal utility ENERGO consists of 8 main separate heating networks serving 9,463 customers across 614,700 m^2 of space. The current generation portfolio relies entirely on natural gas through conventional boilers and high-efficiency CHP units, consuming approximately 9 million Sm^3 of gas annually and underscoring the urgent need for a comprehensive decarbonization strategy.

The main challenge to decarbonize the existing network lies in spatial network fragmentation, customer-owned outdated substations, complex property rules, and the need to keep tariffs as competitive as possible compared to individual gas heating. The most viable RES/WH potential lies in low-temperature municipal waste heat from a coastal wastewater treatment plant (WWTP), while solar and biomass options are constrained by local geography and supply chains.

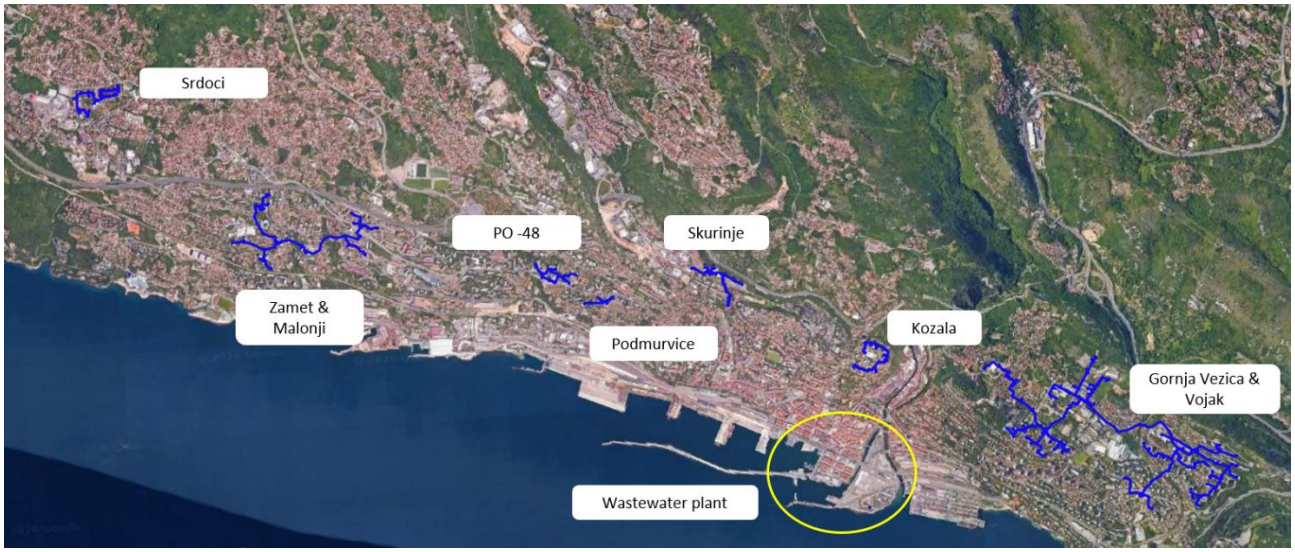


Figure 1 - Existing networks in Rijeka and location of the wastewater plant

2. Solutions and Investment Scenarios Assessed

The technical feasibility assessment for decarbonizing the Rijeka District Heating System focuses on waste heat recovery from a local water treatment plant using large-scale heat pumps—conservatively estimated at a COP of 2.90. Three main interconnection scenarios are explored to connect existing isolated networks and new public buildings to fully exploit the renewable potential of the heat pump and reduce fossil-fuel reliance

Scenario 1 (Global Interconnection) unifies all isolated networks into a single grid using a 18 MW wastewater heat pump and a 2,000 m^3 thermal storage unit, requiring 17.46 km of new piping.

Scenario 1 achieves a 62% renewable heat share and reduces annual CO2 emissions by 42%. However, its high capital expenditure (38.14 M€) and extensive technical complexity yield poor financial metrics (negative NPV and negative IRR).



Figure 2 - Scenario 1 overview

Scenario 2 (Strategic Interconnection) connects six central and eastern networks to a 12 MW wastewater heat pump and a 1,000 m^3 thermal storage unit, requiring 13.2 km of new piping. It cuts capital expenditure to 27.2 M€ while maximizing thermal capacity density. The heat pump delivers 64% of total demand cutting annual natural gas consumption by 41%. The European energy efficiency directive (EED) targets are met by leveraging renewable power from Power Purchase Agreements.



Figure 3 - Scenario 2 overview

Scenario 3 (Zamet Interconnection) targets the isolated western network area using 2.55 km of new piping to link a 4 MW heat pump and 300 m^3 thermal storage unit at the Bazen facility. It achieves a 71%

renewable supply share, cuts gas boiler reliance to 9%, and requires 6.7 M€ in CAPEX. An alternative 6 MW heat pump variant without storage was evaluated but proved financially inferior due to higher capital costs and operational inflexibility during low-demand summer periods.



Figure 4 - Scenario 3 overview

All scenarios directly support the EU Energy Efficiency Directive (EED) Article 26 criteria for efficient district heating systems by surpassing mandatory thresholds for renewable energy and waste heat integration.
Scenario 2 and Scenario 3 were selected as effective decarbonization pathway balancing infrastructure scale with financial and technical viability and achieving near-complete system decarbonization across both eastern and western areas, provided an assumed level of funding to support the initiative.

3. Investment and Implementation Outlook

3.1. Expected Impact

Scenario 2 and Scenario 3, selected for project implementation, yield the following KPIs:

Project KPI	Scenario 2 (central-east)	Scenario 3 (west)
Total length of new pipelines	13.2 km	2.55 km
New Generation assets	12 MW heat pump + 1,000 m^3 thermal storage	4 MW heat pump + 300 m^3 thermal storage
Heat demand served	84 GWh/yr	25 GWh/yr
Renewable share	64%	71%
Total CAPEX	27.2 M€	6.7 M€
Net Present Value (NPV) at year 15	4.09 M€	0.48 M€
IRR with ETS2 (payback)	9.68% (10 years)	7.18% (13 years)

From a technical perspective, the plan unifies existing networks and integrates two wastewater heat pumps and thermal storage across the network. To manage the relevant elevation head across the network, the thermo-hydraulic simulation underscored the necessity to implement specific pressure-mitigation measures such as distributed booster pumping stations, a shut-off valve and a heat exchanger in Vojak for Scenario 2 and strategic booster pump stations along the new backbone connecting the main facilities for Scenario 3. Compared to the baseline, dispatching dynamics change significantly, with the heat pump covering most of the thermal demand and gas boiler usage restricted to peak periods during the winter season.

Furthermore, from an economic perspective, accounting for the future ETS2 directive under funding rates of 30% for the network and 45% for the heat pump allow IRR values of 9.68% (scenario 2) and 7.18% (Scenario 3) by year 15 without changing the current heat tariff.

Finally, from an environmental point of view, replacing fossil-fuel generation with heat pumps powered by renewable electricity through Power Purchase Agreements (PPAs) cuts annual natural gas consumption from 8,830 kSm^3 to 5,178 kSm^3 in Scenario 2 alone. This results in a 42% decrease in total CO2 emissions for the central-eastern system (avoiding approximately 10,000 tons of CO2 annually in global terms) and reduces reliance on gas boilers to just 20% and 9%, respectively, in Scenario 2 and Scenario 3.

3.2. Implementation Roadmap

The implementation of the combined pathway (Scenario 2 and Scenario 3) is structured in four phases across 5–6 years:

- **Phase 1 - Funding & Capacity Allocation (~6 months):** secure funding rate and define total new thermal capacity of new clients along interconnection routes.

- **Phase 2 - Design & Permitting (~9–12 months):** complete detailed hydraulic designs and selection of the heat pumps and thermal storages while securing necessary land-use, road opening, pressure equipment, and electrical connection permits.
- **Phase 3 - Construction (~3–4 years):** install 15.75 km of pre-insulated piping across 5 lots ensuring optimal urban traffic management and construction of heat pump and thermal storage infrastructure.
- **Phase 4 - Commissioning & Ramp-Up (~6 months):** conduct hydraulic testing, tie-in operations, and progressive operational ramp-up under SCADA monitoring to verify compliance with Energy Efficiency Directive (EED) targets.

3.3. Key Risks and Enabling Conditions

The risk assessment identifies four critical risk factors alongside specific mitigation measures required for successful implementation:

- **Technical Risks:** expanding the grid and connecting new end-users or assets poses technical challenges due to steep topographical elevations, high static pressure heads (up to 114 m above sea level), and COP performance uncertainties. Key mitigations include deploying distributed booster pumping stations, installing a shut-off valve at the Kozala crossing, integrating a heat exchanger at Vojak for hydraulic isolation, and conducting specific prefeasibility analysis on the heat pump before installation.
- **Financial Risks**: project economic feasibility is vulnerable to higher capital expenditures, increased maintenance costs, and prolonged construction period (beyond 5 years) . Mitigation requires conducting robust, multi-scenario financial sensitivity modeling to guide decision-making and focusing on long term planning before starting construction
- **Regulatory Risks:** unavailability or insufficiency of public financial incentives and funding schemes represents a significant barrier to achieving target profitability. Mitigation requires pursuing additional EU and national co-financing opportunities eventually aiming for grant rates above the baseline 30% for networks and 45% for heat pumps.
- **Implementation Risks:** infrastructure rollout faces traffic congestion, road excavation constraints in densely populated urban zones, complex permitting protocols, and potential end-user disconnection or adoption hurdles. Mitigations include phasing network construction across five distinct lots (averaging 2 km/year), securing advance road opening licenses and establishing clear communication channels for affected residents.

During commissioning and operation, continuous operational and financial tracking is recommended to guarantee compliance with EU Energy Efficiency Directive decarbonization targets and alignment with the outlined economic performance.

3.4. Stakeholder Engagement & Endorsement

Stakeholder engagement for the investment plan is structured across all project phases to ensure alignment between municipal objectives, utility operations, and local regulatory requirements. Core coordination involves ENERGO as the network operator, the City of Rijeka as majority owner, HEP-ODS as the distribution system operator, and the Public Utilities Commission.

These entities collaborate to navigate local licensing, secure road opening permits, and finalize utility connection agreements for electrical infrastructure upgrades at the wastewater treatment plant. Furthermore, engagement includes targeted outreach for public building connections, advance communication with residents regarding construction traffic and road excavations, and pre-commissioning notices about renewable energy integration and service tie-ins.

4. Conclusions and Key Lessons

The comprehensive technical, financial, environmental, and strategic assessment conducted for the Rijeka District Heating System (DHS) demonstrates that interconnecting currently isolated, fossil-fuel-dependent networks around large-scale heat pumps utilizing waste heat from the local wastewater treatment plant (WWTP) provides a highly effective and feasible pathway toward full decarbonization. Integrating thermal storage is critical for operational stability, enabling continuous, full-load heat pump operation during off-peak hours (e.g., overnight or during low summer baseloads), preventing unnecessary curtailment and shaving peak demand during cold periods.

The combined deployment of Scenario 2 and Scenario 3 enables the heat pumps to satisfy respectively 64% and 71% of the annual heat demand in their targeted areas, supported by green electricity secured through Power Purchase Agreements (PPAs). This drastically reduces dependence on fossil fuels, cutting annual CO_2 emissions significantly, fully aligning the system with the ambitious targets set by the EU Energy Efficiency Directive (EED) and the local SECAP.

While baseline financial indicators remain tight, modest adjustments in funding support (e.g., a 5% increase over baseline grant rates) bring the Internal Rate of Return (IRR) to the target threshold of 10% for both main developments, ensuring tariff stability for end-users.

For other European municipalities and district heating operators facing similar challenges, the Rijeka experience serves as a clear, replicable model for transforming fragmented fossil-based grids into modern, efficient, and resilient district energy systems driven by municipal waste heat.

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GET IN TOUCH

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